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ABSTRACT

Four experiments on speech reception and speech production in deaf children are reported. In study 1, conversations of seven deaf children (6 to 12 years old) were recorded and analyzed, indicating that their speech was no less intelligible than their normally hearing peers. The deaf children had received 3 or more years of parent/infant training. Study 2 demonstrated that skills acquired by 17 deaf children (10 to 17 years old) taught by cued speech did not transfer to everyday communicative speech. Study 3, involving seven pairs of profoundly hearing impaired children (5 to 7 years old) demonstrated that children taught to produce speech patterns learned more phonetic level targets than children who merely listened and discriminated speech patterns without producing them. The final study showed that cued speech is a viable method of providing deaf children with a method of effective speech reception. (CL)

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FOUR EXPERIMENTS ON SPEECH

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Four Experiments on Speech

The four reported experiments were undertaken at McGill University by the writer and/or his students. The first two are concerned with speech production and the final two, with speech reception.

Experiment 1. Speech Production by Profoundly Hearing Impaired Children. (Ling and Milne).

Review of the literature indicates that very poor speech production skills are common among children who have levels of hearing impairment greater than 90 dB (ISO). In most studies reported over the past 40 years, such children have, on average, achieved intelligibility scores ranging from 18 to 31 percent and their speech has contained numerous errors that have come to be regarded as typical of "deaf speech." These errors include omission and distortion of consonants; omission, nasalization, prolongation, and neutralization of vowels; vocal tension; and lack of breath control (Nickerson, 1975). A recent survey published at Gallaudet College (Jensema, Karchmer & Trybus, 1978) has shown that such poor speech currently tends to be typical in many school programs and not to improve significantly with age and duration of training.

Findings such as those reported above suggest either that deafness is an insuperable barrier to clear speech or that current programs are not adequately geared towards speech training. The writer believes that the latter is the case (Ling, 1976). He has claimed that high level speech skills can be achieved by most hearing impaired children, even those whose handicap is profound, and that most faults that are considered typical of "deaf speech" can be avoided or overcome through adequate teaching. The value of speech to hearing impaired persons is not questioned by informed professionals or by most hearing impaired people themselves. Thus it is important to know whether clear speech is a reasonable goal for those born with profound hearing impairment and, if so, what procedures can be adopted by professionals to help them achieve this goal.

The subjects in this study were seven children, three boys and four girls, with hearing impairment of more than 90 dB in their better ears. They were drawn from a population of nine such children who had attended the McGill Project for Deaf Children from early infancy over a period of three years or more from 18 months of age, or less. None had handicaps in addition to deafness. Following their early parent/infant training program they were placed in regular schools. At the time of this study they were aged from 6 to 12 years of age.

Each subject was engaged in a conversation, which was recorded. The recordings were then analyzed and five sentences from 5 to 9 words each were dubbed on to another tape for the purpose of rating intelligibility. Every tenth or nearest to tenth sentence of this length was extracted to ensure (1) that the speech was representative of the child's production and (2) that listeners received no context cues. A control group of children with no history of deafness or communication problems, matched in age and sex, was then drawn from regular school classes. Conversations with each of them were recorded, analyzed, and dubbed in the same way.

A group of 17 incoming graduate students in Communication Disorders was given the task of listening to the recordings, and writing down what each child said. The number of words correctly identified in each sample was then tallied and expressed as a percentage score for each child. A comparison of speech intelligibility of the two groups was carried out. Results are shown in Table 1. Pairs (hearing impaired versus normally hearing) are shown opposite to each other. Thus Subject 1 was paired in age and sex with Subject 8, Subject 2 with Subject 9 and so on. The mean scores for each group are shown in the bottom row.

Statistical tests indicated that the hearing impaired subjects were no less intelligible than their normally hearing peers. Such results indicated that profound hearing impairment is not an insuperable barrier to clear speech and suggest that the widespread failure to attain highly intelligible speech in school program reflects inadequate training strategies rather than children's inability to learn. Not all seven children had normal sounding speech. Four showed a few of the faults

Table 1

Percent Intelligibility Scores
for All Fourteen Subjects

Hearing Impaired		Normally Hearing	
Subject	Score	Subject	Score
1	91	8	95
2	98	9	94
3	74	10	93
4	78	11	92
5	91	12	90
6	85	13	75
7	56	14	71
Mean	81.9	Mean	87.1

typically associated with "deaf speech." However, the speech program which was provided for these children was in its experimental stages and helped to shape the framework of the system of training later proposed by Ling (1976). We feel that the faults that were present could have been avoided if our present knowledge of the speech acquisition process had been available when we were first teaching these subjects.

Experiment 2. Speech Training with Older Hearing Impaired Children. (Ling).

Where programs for hearing impaired infants and their parents do not exist, or for some reason have failed, pupils with various speech problems may be found in elementary schools. Some may have acquired little or no speech. Others may speak a great deal, but unintelligibly.

Children at both of these extremes need remedial speech training. In theory, those who have most speech will be the hardest to teach, since their continuous use of inappropriate patterns will have led to habitual faults in production that must be eradicated and replaced with accurate and acceptable speech. Without appropriate remedial help at the elementary level, faulty speech may persist into the high school grades or become a permanent feature.

What constitutes appropriate remedial speech teaching in the elementary or high school grades is by no means clear. Work at a phonetic (non-meaningful) level would seem to be necessary, in order to ensure that a child attains mastery of the neuromuscular coordinations that are essential in running speech. However, work at a phonetic level is unlikely to be sufficient, since habitual errors made in the course of communication have to be supplanted. The effects of teaching at a phonetic level and encouraging clear communicative speech in a casual manner during class lessons were assessed.

The subjects were 17 prelingually, profoundly hearing impaired children aged from 10 years 2 months to 17 years 6 months who were taught by means of Cued Speech. All were able to communicate through spoken language although only six could be considered as intelligible to persons unfamiliar with their speech. Their teachers were trained daily for four weeks in speech improvement strategies by the writer through readings, explanation, and demonstration of the system he advocates (Ling, 1976). The subjects' phonetic level skills were assessed during this month and again after a one-year period. During the year, daily speech training was provided and communication through speech was encouraged by the teachers.

To compare pre- and post-training performance at a phonetic level, the number of suprasegmental (prosodic) and segmental (vowel and consonant) patterns each child was capable of producing were tallied. The scores obtained are shown in Table 2. Gains in phonetic level skills were made by all but one of the children. The child who gained most learned 33 new target behaviors; the child who gained least learned none. The mean gain for the group was 12.7 new phonetic level patterns.

Table 2

Phonetic Level Evaluation Scores

Subject	Age	Average Hearing Level	Phonetic Level Evaluation Scores		
			1978	1979	Gain
1	17.6	122	21	54	33
2	16.1	117	42	72	30
3	15.6	100	32	59	27
4	11.4	97	36	60	24
5	14.3	98	23	37	14
6	14.3	103	20	33	13
7	13.10	98	27	40	13
8	14.1	100	29	41	12
9	14.4	110	23	33	10
10	15.6	105	27	36	9
11	14.2	105	22	30	8
12	10.2	117	14	22	8
13	14.10	98	18	24	6
14	15.2	120	30	35	5
15	15.6	107	29	32	3
16	16.2	103	36	37	1
17	14.3	105	28	28	0

To measure pre- and post-training performances at a phonologic level, two samples of 100 spontaneous utterances from each child were recorded on audiotape, one pre- and the other post-training. These were transcribed. Speech patterns that were consistently used correctly were identified and tallied. Comparison of the scores achieved before and after training showed that no significant gains had been achieved. Phonologic level scores following training were within one or two points of those recorded at the beginning of the year.

The outcome of this study indicates that speech acquisition, even at the phonetic level, was difficult for some of these hearing impaired children. The difficulty, however, was not related to either age or hearing levels within the group studied. Nor was progress in phonetic level skills related to the performance level of the children at the outset. Some of those with the best scores on the pre-training test were among those who made the least gain. Teachers' skills and attitudes to speech teaching were not assessed but are suggested as a possible variable relating to the children's performance.

That skills acquired through speech training at the phonetic level did not transfer to everyday communicative speech suggests that far more rigorous effort is required to ensure generalization. Such effort would appear to demand that the use of speech patterns taught by a given teacher at the phonetic level should be systematically encouraged by different people, at different times and places during the child's day, and in different situational and grammatical contexts. Because these children had clear knowledge of the phonemic structure of speech, derived from Cued Speech (see Nicholls, 1979 for further details), one might speculate that generalization could, if it were sufficiently emphasized, be achieved quite readily. The intelligibility of the subjects' speech was found to correlate closely with their phonologic scores, ($rho = .95$; $p < .001$). A significant (.001) correlation also existed between phonetic and phonologic level skills, ($r = .71$). Thus this study confirmed the hypothesis that phonetic level training is necessary but not sufficient in developing speech in older children and the findings indicate a compelling need for more systematic work on generalization of phonetic level skills into speech communication.

Experiment 3. Speech Reception as a Function of Speech Production. (Novelli-Olmstead).

It has been suggested that skill in speech production serves as an aid in speech reception (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). Until recently, this hypothesis had not been tested. To determine whether speaking skills help listening skills is important in the training of hearing impaired children, because the common practice is to give priority to speech reception and the best approach may not be to talk, talk, talk (especially if the child is deaf, deaf, deaf).

In this study seven pairs of profoundly hearing impaired children aged five to seven years served as subjects. The pairs were matched on their ability to produce sound patterns at a phonetic level, i.e., through imitation. The members of each pair were randomly assigned to one of two groups. The first group (A) consisted of four girls and three boys. They were designated as the "active" group. The remaining group (B) was designated as their "passive" partners. Both members of each pair were trained through the use of a single speech training aid equipped with two pairs of headphones. One member, the "active" child, was taught to produce speech patterns; the other, to listen and discriminate these patterns but not to say them.

Both before and after 30 training sessions, each of 15 minutes duration, a test of auditory discrimination was administered. This test consisted of labelling each of two colored cubes with a syllable and then asking the child to point to one of the pair. For example, in one trial a blue cube was designated as [ba] and its red counterpart as [ma]. After hearing the two syllables, the child was asked to point to the cube representing [ma]. The number of each child's correct responses was recorded.

The training was found to yield two major results. First, the children in Group A, those who received "active" speech-teaching, learned more phonetic level targets than children in Group B, those who just listened. Second, the children in Group A also made significantly greater gains in speech discrimination.

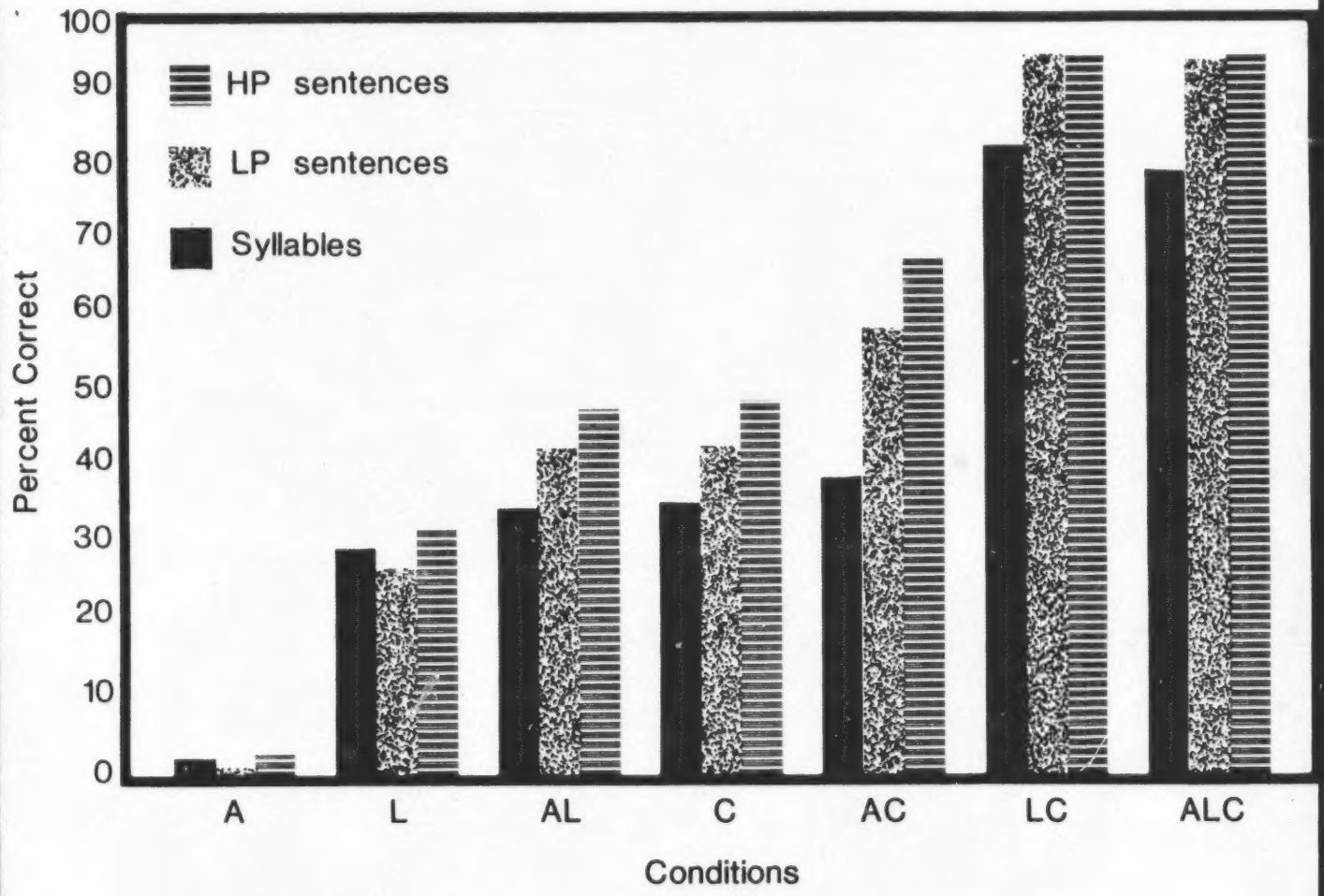
The outcomes of this study clearly demonstrated that speech production is not merely a means of expression but also a very powerful tool in speech reception. Evidently the child's knowledge of the speech patterns present in language provides a framework which helps in the discrimination of the incoming speech signals. The implication is, of course, that speech and auditory training should not be regarded as separate skills, but should be integrated in the teaching process.

Experiment 4. Cued Speech and the Reception of Spoken Language. (Nicholls).

Very few studies on Cued Speech have been conducted. This is unfortunate because it must be clear to the thoughtful professional that it is impossible for an auditory-oral approach to work with all children. Some have so little hearing (or none) that they cannot use audition either as the primary sense channel for speech reception or as a sufficiently useful support to lipreading. At least for such children Cued Speech can, theoretically, offer a means of receiving and developing spoken language skills. Because Cued Speech offers a visual means of speech reception, it may be regarded as a visual-oral system. As such, its use with children who cannot benefit adequately from an auditory-oral approach ought to be considered.

In her study, Nicholls (1979) studied 18 profoundly hearing impaired Australian children who had been taught through Cued Speech for at least four years. Prior to their education through Cued Speech, all subjects had failed to acquire effective verbal language and communication by other (oral or manual) methods. They ranged from 9:2 to 16:9 years in age and their average hearing levels ranged from 97 to 122 dB (ISO) in the better ear. They were tested under seven conditions: audition alone (A); lipreading alone (L); audition plus lipreading (AL); Cues alone (C); audition plus Cues (AC); lipreading plus Cues (LC); and audition, lipreading, and Cues (ALC). Two types of stimuli were employed: syllables and key words in sentences. All materials were videotaped by a native Australian female speaker who was fluent in the Australian use of Cued Speech.

Figure 1. Scores obtained for syllables and words in high predictability (HP) and low predictability (LP) sentences.



The main results of Nicholls' study are summarized in Figure 1, which shows that over 80 percent of syllables and over 95 percent of key words in sentences were correctly identified under the LC and ALC conditions. Such levels of speech reception by profoundly hearing impaired children have never before been reported. Results also showed that the subjects were able to lipread as well as those described in the literature, and that subjects who had residual hearing were able to use it effectively.

This study showed that Cued Speech is truly a viable method of providing profoundly and totally deaf children with a means of effective speech reception. To be sure, only 18 subjects were evaluated, but they were all of the children present in the program. They were, otherwise, not a selected group. Indeed, five of the group had learning problems. The program itself was carefully designed to provide the children with specific auditory training, language learning experience, and academic work. Skills in all of these areas were of a high level. Thus Cued Speech within such a program was demonstrably effective. With less able teaching, it would, like any other method, be less likely to lead to high level linguistic and academic performance. Probably no approach can compensate for inadequate teaching. What is clear from this study is that Cued Speech can be highly effective within a well-structured program.

Further research on Cued Speech is required. Of particular interest is how effectively it can be used with different age groups, children with different (less severe) hearing impairment, and children with handicaps in addition to deafness. The primary purpose of Cued Speech is to facilitate the reception and development of spoken language. Further longitudinal studies of Cued Speech that focus upon the language development of the children rather than upon their speech reception skills would therefore be of compelling value.

Concluding Comments

The four recently completed studies on speech reception and speech production reported above have provided answers to some important

questions. They are all concerned with evaluation of procedures. Such evaluations are not the sole concern of research workers. They must also be part of the work routinely carried out by those who teach. Without evaluation of speech reception skills, language competence, and speech production abilities, teachers cannot systematically gear their work to the needs of the individual child. Future research should, therefore, focus upon providing simple and effective evaluation tools for those who work directly with children.

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